Emergence patterns of terminal weevils (Coleoptera: Curculionidae) and their parasitoids from lodgepole pine in the Interior of British Columbia, Canada

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ABSTRACT

Three terminal weevil species emerged from 82 infested leaders collected at two locations in the Okanagan Valley. The most abundant species was *Pissodes terminalis* Hopping. *Magdalis gentilis* LeConte started to emerge at the beginning of May whereas *P. terminalis* and one species of *Cylindrocopturus* emerged a month later. Parasitoids reared from weevil infested terminals belonged to nine species in six families of the Order Hymenoptera. The most important species was the pteromalid *Rhopalichus pulchripennis* Crawford but two species of *Eurytoma* collectively ranked second in abundance. Emergence of the majority of the parasitoids preceded that of *P. terminalis* and *Cylindrocopturus* sp.

INTRODUCTION

Terminal weevils often cause serious damage to young coniferous trees by attacking terminal shoots (Keen 1952). According to Keen (1952) the three most important genera of twig weevils are *Pissodes, Magdalis* and *Cylindrocopturus.*

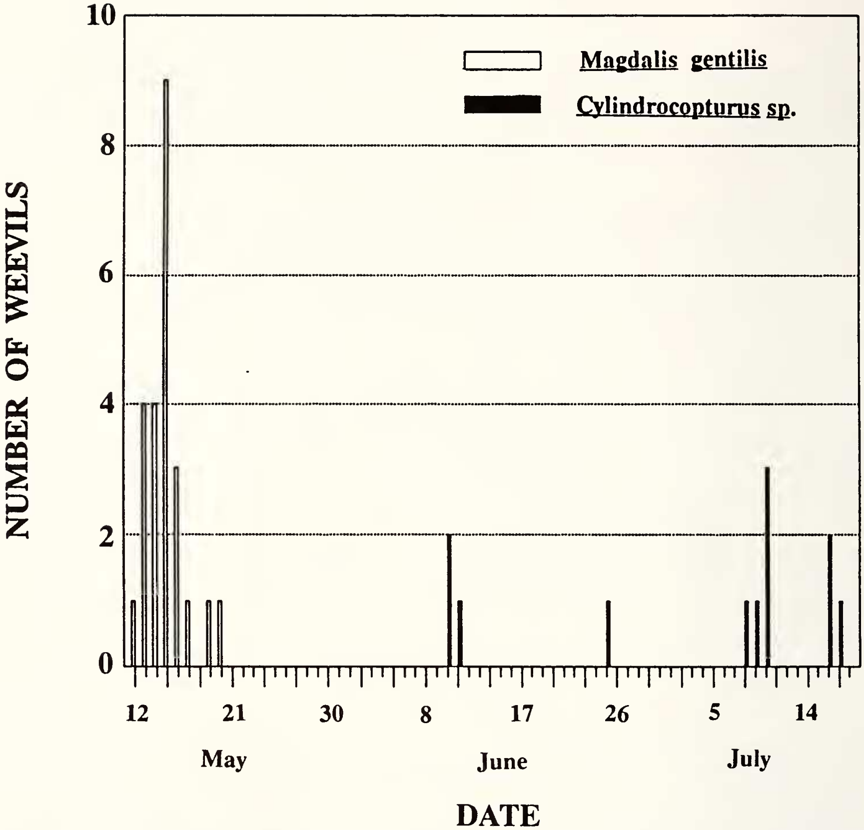
The lodgepole terminal weevil, *Pissodes terminalis* Hopping is the most important weevil species attacking leaders of lodgepole pine, *Pinus contorta* Doug. ex Loud., in British Columbia. The occurrence of Magdalis and *Cylindrocopturus* species in the province has been reported by Furniss and Carolin (1977) but the first damage caused by *M. gentilis* Lec. was observed and reported by the Forest Insect and Disease survey (FIDS) only in 1987 (Wood *et al.* 1987).

Fellin and Schmidt (1966) reported that the damage caused by *M. gentilis* "did not appear to be restricted to any particular portion of the crown." Adults puncture needles so that the distal portions desiccate and discolor (Fellin and Schmidt 1966), and are broken off by wind, rain or snow (Plumb 1950; Fellin 1973). Fellin (1973) stated that defoliation was the only type of damage he had observed. However, Kovacs' (1988) observations support the findings of Furniss and Carolin (1977) that larvae of *M. gentilis* mine branches as well as leaders. Damage caused by *Cylindrocopturus* spp. is similar to that of *M. gentilis.*

Leader clipping trials (MoF 1982, 1983, 1984) were carried out in the Cariboo Forest Region to reduce populations of *P. terminalis.* Leaders were clipped in July. Development of effective control methods requires they are consistent with the biology of the target species.

Losses caused by *M. gentilis* and *Cylindrocopturus* spp. are not considered important (Furniss 1942; Fellin 1973; Furniss and Carolin 1977) and therefore, no practical measures have been developed for their control. In the absence of effective control methods it seems that natural control will play the most important role in reduction of numbers of these pests.

Detailed studies have been carried out on insects associated with *Pissodes strobi* Peck. on eastern white pine, *Pinus strobus* L. (Harman and Kulman 1967), on Engelmann spruce (VanderSar 1978) and on Sitka spruce, *Picea sitchensis* Bong. (Carr.), (Stevenson 1967; Alfaro *et al.* 1985). However, no information is available on the parasite-predator complex of other leader weevils in British Columbia.



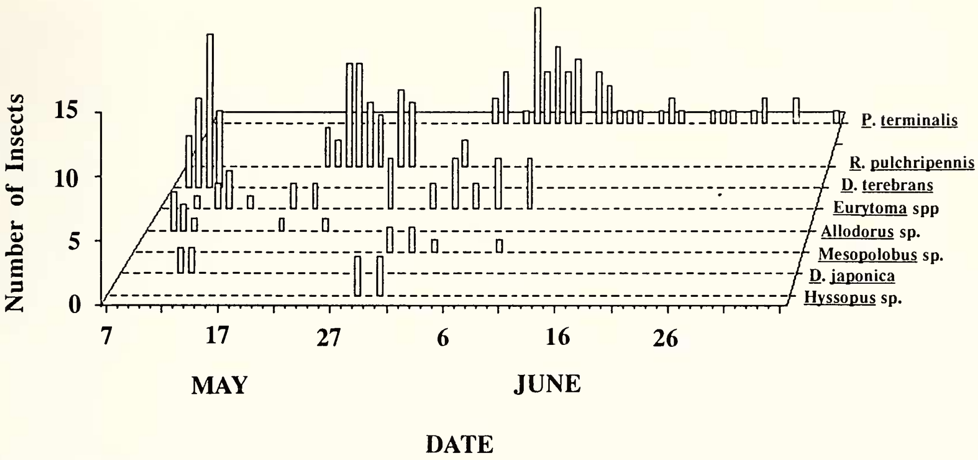
METHODS AND MATERIALS

In 1987, 737 dead leaders killed by terminal weevils were collected between May 7–11 in young spaced lodgepole pine stands in the southern Interior of British Columbia. Most of the leaders (641) were collected at Ellis Creek, 20 km east of Penticton and the rest (96) on the Big White Road, 30 km southeast of Kelowna. The terminals were incubated individually in cardboard mailing tubes. A small vial for trapping emerging weevils was inserted into the lower half of one of the end caps. The tubes were maintained at 20 ± 2°C. Emerging specimens were collected daily and either preserved in 70% alcohol or pinned. Specimens were submitted to the Biosystematic Research Institute in Ottawa for identification.

RESULTS AND DISCUSSION

Individual rearing, which started between May 7–11, 1987 revealed that in addition to *P. terminalis, M. gentilis* and *Cylindrocopturus* sp. were also present in the Penticton and Kelowna areas. Earlier rearings by Kovacs (1988) showed that *M. gentilis* can also be found in young lodgepole pine stands in the Cariboo Forest Region.

Weevils of all three species emerged from 82 lodgepole pine leaders (11.1%), whereas parasitoids emerged from 127 terminals (17.4%). The low emergence rate was probably the result of desiccation of the terminals in the mailing tubes which resulted in the death of larvae and pupae.



The first weevil species to emerge from dead leaders under laboratory conditions was *M. gentilis* which started emerging on May 12, 1987 and finished seven days later (Fig. 1). On June 3, 1987 (30 days in rearing) *P. terminalis* started to emerge and it reached its peak on June 7, 1987 (Fig. 2). Emergence continued until July 7, 1987. *Cylindrocopturus* sp. emerged between June 10, 1987 and July 16, 1987 (Fig. 1). The constant temperatures in the rearing regime meant that this material accumulated a thermal heat sum at a greater rate than was occurring under diurnal forest conditions. Reared material was approximately 12 days ahead by the end of June, calculated above a threshold temperature of 5°C. Enhanced heat sum accumulation needs to be considered when referencing the temporal sequences in Figs. 1, 2.

Many parasitoids were also reared from the terminals. They belonged to six families in the order Hymenoptera (Table 1). As leaders were attacked by a terminal weevil complex correct association between individual host species and parasitoids cannot be assured. In the course of this study neither predators nor entomophagous fungi were found in association with any of the weevils.

All samples were dominated by *Rhopalicus pulchripennis* Crawford (Hym.: Pteromalidae) and two species of *Eurytoma* (Hym.: Eurytomidae) collectively ranked second in abundance. *Dolichomitus terebrans nubilipennis* (Viereck) (Hym.: Ichneumonidae) was particularly abundant on one of the sites east of Penticton. These parasitoids have also been reported to attack *P. strobi* (VanderSar 1978; Alfaro *et al.* 1985). One *Mesopolobus* species has also been reported as a parasitoid of *P. terminalis* (Stevens and Knopf 1974).

Figure 2 shows emergence patterns of the parasitoids from infested lodgepole pine leaders in relation to that of *P. terminalis.* The parasitoid complex had a bimodal emergence pattern. Most of the parasitoids emerged earlier than *P. terminalis. D. terebrans* emerged between May 8–11 and the peak occurred on May 10, 1987. Stevenson (1967) reported that *D. terebrans* emerged in the field from late May to the third week of June with a peak about mid-June. The pteromalid *R. pulchripennis* started to emerge on May 20, 1987 and emergence was completed on June 2, 1987. Emergence of the two eurytomids lasted for a month and was fairly constant.

It was observed that one of the sites on a south facing slope had high numbers and a wide variety of parasitoids. This site supported an abundance of fireweed, *Epilobium angustifolium* L. and one species of lupin, *Lupinus.* Several adult parasitoids were observed feeding on nectar of these plants.

Table 1
Hymenopterous parasitoids found associated with terminal weevils in British Columbia, 1986-1987.

Family	Genus/Species	Location	Relationship to weevils	Time of emergence
Braconidae	*Allodorus* sp.	Kelowna Penticton Prince George Williams Lake	Endoparasitoid	Spring
	Coeloides rufavariegatus (Prov)	Kelowna	Ectoparasitoid	Spring
Eulophidae	*Hyssopus* sp.	Kelowna Penticton	Endoparasitoid	Summer
Eurytomidae	*Eurytoma* spp.	Kamloops Kelowna Merritt Penticton Prince George Williams Lake	Ectoparasitoid	Summer
Ichneumonidae	*Dolichomitus terebrans nubilipennis* (Ratzeburg)	Penticton Williams Lake	Ectoparasitoid	Spring
	Delomerista japonica Cushman	Penticton	Ectoparasitoid	Spring
Pteromalidae	*Rhopalichus pulchripennis* Cwfd.	Kamloops Kelowna Merritt Penticton Prince George Williams Lake	Ectoparasitoid	Summer
	Mesopolobus sp.	Kamloops Merritt Penticton	unknown	Summer
Scelionidae	*Telenomus* sp.	Kamloops Williams Lake	Endoparasitoid	Summer

MANAGEMENT IMPLICATIONS

Leader clipping trials near Prince George in the early 1980s (MoF 1984) failed to have any effect on the weevil population as clipping was done in July, a time when most weevils had probably already emerged. Therefore, knowledge of emergence patterns of the weevils is important in planning leader clipping projects. Early emergence of *Magdalis gentilis* suggests that clipping should be carried out by early spring.

Field observations indicated that the best time for clipping is February because almost all attacked leaders have already changed color to a dull brown by this time which facilitates recognition of infested terminals. Experience has also shown that the top of the snow is hard in February which facilitates easy walking in the stands. In addition, the depth of the snow helps the worker to reach the infested leaders and minimizes bending of the cold-brittle trees. The only disadvantage of February leader clipping is that many parasitoids would be removed in the leaders. Parasite enhancement techniques such as containing the clipped leaders in a mesh covered drum, as has been proposed for *P. strobi* (Hulme *et al.* 1987) might be successfully implemented for *P. terminalis.*

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Compatibility of the winter moth parasitoid *Cyzenis albicans* (Tachinidae) with pesticide use in the cultivation of blueberries in the Fraser Valley

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ABSTRACT

The potential for the use of the tachinid fly, *Cyzenis albicans* Fall., as an alternative control of winter moth, *Operophtera brumata* L. on blueberries was evaluated with respect to the flies' compatibility with late season clean-up insecticide sprays. Pupae of *Cyzenis* suffered no greater mortality when exposed to malathion sprays than did those not exposed to such sprays. Mechanisms of protection for the tachinid from insecticides and its potential for biological control in blueberries are discussed.